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A
SYNOPSIS
OF THE
ASTRONOMY
OF
COMETS.

By EDMUND HALLEY,
Savilian Professor of Geometry,
at Oxford; And Fellow of the
Royal Society.

*Translated from the ORIGINAL,
printed at Oxford.*

L O N D O N :
Printed for John Senex, next to the Fleece-
Tavern, in Cornhill. 1705.

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SYNOPSIS

OF THE

Astronomy of Comets.

THE ancient Egyptians and Chaldeans (if we may credit *Diodorus Siculus*) by a long Course of Observations, were able to predict the Apparitions of Comets. But since they are also said, by the Help of the same Arts, to have prognosticated Earthquakes and Tempests, 'tis past all Doubt, that their Knowledge in these Matters, was the Result rather of meer *Astrological Calculation*, than of any *Astronomical Theories* of the Cœlestial Motions. And the Greeks, who were the Conquerors of both those People, scarce found any other sort of Learning amongst them, than this. So that 'tis to the Greeks themselves as the Inventors (and especially to the Great *Hipparchus*) that we owe this *Astronomy*, which is now improv'd to such a Heighth. But yet, amongst these, the Opinion of *Aristotle* (who wou'd have Comets to be nothing else, but Sublunary Vapours, or Airy Meteors)

prevail'd so far, that this most difficult Part of the Astronomical Science lay altogether neglected; for no Body thought it worth while to take Notice of, or write about, the Wandering uncertain Motions of what they esteemed Vapours floating in the *Aether*; whence it came to pass, that nothing certain, concerning the Motion of Comets, can be found transmitted from them to us.

But *Seneca* the *Philosopher*, having consider'd the *Phænomena* of Two remarkable Comets of his Time, made no Scruple to place them amongst the *Cælestial* Bodies; believing them to be *Stars* of equal Duration with the World, tho' he owns their Motions to be govern'd by Laws not as then known or found out. And at last (which was no untrue or vain Prediction) he foretells, that there should be Ages sometime hereafter, to whom Time and Diligence shou'd unfold all these Mysteries, and who shou'd wonder that the Ancients cou'd be ignorant of them, after some lucky Interpreter of Nature had shewn, in what Parts of the Heavens the Comets wander'd, what, and how great they were. Yet almost all the Astronomers differ'd from this Opinion of *Seneca*; neither did *Seneca* himself think fit to set down those *Phænomena* of the Motion, by which he was enabled to maintain his Opinion: Nor the Times of those Appearances, which might be of use to Posterity, in order to the Determining these Things. And indeed, upon the Turning over very many Histories of Comets, I find nothing at all that can be of Service in this Affair, before, A. D. 1337. at which time *Nicephorus Gregoras*, a Constantinopolitan Historian and Astronomer, did

pretty accurately describe the *Path* of a Comet amongst the Fix'd Stars, but was too laxe as to the Account of the *Time*; so that this most doubtful and uncertain Comet, only deserves to be inserted in our Catalogue, for the sake of its appearing near 400 Years ago.

Then the next of our Comets was in the Year 1472, which being the swiftest of all, and nearest to the Earth, was observ'd by *Regiomontanus*. This Comet (so frightful upon the Account both of the Magnitude of its Body, and the Tail) mov'd Forty Degrees of a great Circle in the Heavens, in the Space of one Day; and was the first, of which any proper Observations are come down to us. But all those that consider'd Comets, until the Time of *Ticho Brahe* (that great Restorer of Astronomy) believ'd them to be below the Moon, and so took but little Notice of them, reckoning them no other than Vapours.

But in the Year 1577, (*Ticho* seriously pursuing the Study of the Stars, and having gotten large Instruments for the Performing Coelestial Mensurations, with far greater Care and Certainty, than the Ancients cou'd ever hope for) there appear'd a very remarkable Comet; to the Observation of which, *Ticho* vigorously applied himself; and found by many just and faithful Trials, that it had not a *Diurnal Parallax* that was at all perceptible. And consequently was not only no Aereal Vapour, but also much higher than the Moon; nay, might be plac'd amongst the Planets for any thing that appear'd to the Contrary; the cavilling Opposition made by some of the

School-men in the mean time, being to no Purpose.

Next to *Ticho*, came the Sagacious *Kepler*. He having the Advantage of *Ticho's* Labours and Observations, found out the true Physical System of the World, and vastly improv'd the Astronomical Science.

For he demonstrated that all the Planets perform their Revolutions in *Elliptick Orbits*, whose Plains pass thro' the Center of the Sun, observing this Law, That the Area's (of the *Elliptick Sectors*, taken at the Center of the Sun, which he proved to be in the common Focus of these *Ellipses*) are always proportional to the Times, in which the correspondent *Elliptical Arches* are describ'd. He discover'd also, That the Distances of the Planets from the Sun are in the *Sesquialtera Ratio* of the Periodical Times, or (which is all one) That the Cubes of the Distances are as the Squares of the Times. This great Astronomer had the Opportunity of observing Two Comets, one of which was a very remarkable one. And from the Observations of these (which afforded sufficient Indications of an *Annual Parallax*) he concluded, That the Comets mov'd freely thro' the Planetary Orbs, with a Motion not much different from a *Rectilinear* one; but of what Kind he cou'd not then precisely determine. Next, *Hevelius* (a Noble Emulator of *Ticho Brahe*) following in *Kepler's* Steps, embraced the same Hypothesis of the *Rectilinear Motion* of Comets, himself accurately observing many of them. Yet, he complain'd, that his Calculations did not perfectly agree to the Matter of Fact in the Heavens: And was aware, that the Path of a Comet was bent into a Curve Line towards the Sun.

Sun. At length, came that prodigious Comet of the Year 1680. which descending (as it were) from an infinite Distance *Perpendicularly* towards the Sun, arose from him again with as great a Velocity.

This Comet, (which was seen for Four Months continually) by the very remarkable and peculiar Curvity of its Orbit (above all others) gave the fittest Occasion for investigating the *Theory of the Motion*. And the *Royal Observatories at Paris and Greenwich* having been for some time founded, and committed to the Care of most *excellent Astronomers*, the apparent Motion of this Comet was most accurately (perhaps as far as Humane Skill cou'd go) observ'd by Mrs. *Cassini* and *Flamsteed*.

Not long after, that *Great Geometrician*, the *Illustrious Newton*, writing his *Mathematical Principles of Natural Philosophy*, demonstrated not only that what *Kepler* had found, did necessarily obtain in the *Planetary System*; but also, that all the *Phænomena* of Comets wou'd naturally follow from the same Principles; which he abundantly illustrated by the Example of the aforesaid Comet of the Year 1680. shewing, at the same time, a Method of Delineating the Orbits of Comets Geometrically; wherein he (not without the highest Admiration of all Men) solv'd a Problem, whose Intricacy render'd it worthy of himself. This Comet he prov'd to move round the Sun in a *Paraboli- cal Orb*, and to describe *Area's* (taken at the Center of the Sun) proportional to the Times.

Where-

Wherefore (following the Steps of *so Great a Man*) I have attempted to bring the same Method to *Arithmetical Calculation*; and that with desired Success. For, having collected all the Observations of Comets I could, I fram'd this Table, the Result of a prodigious deal of Calculation, which, tho' but small in Bulk, will be no unacceptable Present to Astronomers. For these Numbers are capable of Representing all that has been yet observ'd about the Motion of Comets, by the Help only of the following *General Table*; in the making of which I spar'd no Labour, that it might come forth perfect, as a Thing consecrated to Posterity, and to last as long as *Astronomy* it self.

Not long after, that Great Cometician, the illustrious Newton, writing his *Arithmetical Principles of Natural Philosophy*, demonstrated not only that what Kepler had found, did necessarily obtain in the *Planetary System*; but also, that all the Parameters of Comets would naturally follow from the same Principles; which he ~~has~~ ^{has} demonstrated by the Example of the aforesaid Comet of the Year 1680. shewing, at the same time, a Method of Determining the Orbits of Comets Geometrically; wherein he (not without the highest Advancement of all Men) solv'd a Problem, whose solution he prov'd to be worthy of himself. This Comet he prov'd to move round the Sun in a Parabolic Orb, and to describe Areas (taken at the Center of the Sun) proportional to the

Where

*Astronomical Elements of the Motions in a Parabolick Orb
of all the Comets that have been hitherto duly observ'd.*

Comet. An	Nodes Ascend.	Inclin. Orbitæ.	Perihelion.	Distan. Log. Diji. Periheli à Sole.	Periheliæ à Sole.	Temp. equat. Periheliæ	Perihelion à Nodo.
gr. ' "	gr. ' "	gr. ' "	gr. ' "	d. h. ' "	d. h. ' "	d. h. ' "	gr. ' "
1337	Π 24.21. c	32.11. 0	Υ 7.59. 0	9.609236	June 2. 6. 25	46.22. 0	Retrog.
1472	Π 11.46.20	5.20. 0	Υ 5.33.30	9.734584	Feb. 28. 22. 23	123.47.10	Retrog.
1431	Υ 19.25. 0	17.56. 0	Σ 1.39. 0	9.753583	Aug. 24. 21. 18	107.46. 0	Retrog.
1532	Π 20.27. c	32.36. c	Σ 21. 7. 0	9.706803	Oct. 19. 22. 12	30.40. 0	Direct.
1556	Π 25.42. c	32. 6.30	Υ 8.50. 0	9.666424	Apr. 21. 20. 3	103. 8. 0	Direct.
1577	Υ 25.52. c	74.32.45	Ω 9.22. 0	9.263447	Oct. 26. 18.45	103.30. 0	Retrog.
1580	Υ 18.57.20	64.40. 0	Σ 19. 5.50	9.775450	Nov. 28. 15.00	90. 8.30	Direct.
1585	Υ 7.42.30	6. 4. 0	Υ 8.51. 0	0.038840	Sept. 27. 19.20	28.51.30	Direct.
1590	Π 15.30.40	29.40.40	Π 6.54.30	9.760882	Jan. 29. 3.45	51.23.50	Retrog.
1596	Σ 12.12.30	55.12. c	Π 18.16. 0	9.710058	Jul. 31. 19.55	83.56.30	Retrog.
1607	Σ 20.21. c	17. 2. c	Σ 2.16. 0	2.768490	Oct. 16. 3.50	108.05. 0	Retrog.
1618	Π 16. 1. c	37.34. 0	Υ 2.14. 0	2.579498	Oct. 29. 12.23	73.47. 0	Direct.
1651	Π 28.10. 0	79.28. c	Υ 28.18.40	9.928140	Nov. 2. 15.40	59.51.20	Direct.
1661	Π 22.30.30	32.35.50	Σ 25.58.40	2.651772	Jan. 16. 23.41	33.28.10	Direct.
1664	Π 21.14. c	21.18.30	Ω 10.41.25	0.011044	Nov. 24. 11.52	49.27.25	Retrog.
1665	Π 18.02. 0	76.05. c	Π 11.54.30	9.027309	Apr. 14. 5.15	156. 7.30	Retrog.
1672	Υ 27.30.30	33.22.10	Υ 16.59.30	9.843476	Feb. 20. 8.37	109.29. 0	Direct.
1677	Π 26.49.10	79.03.15	Ω 17.37. 5	2.8059	Apr. 26. 00.37	99.12. 5	Retrog.
1680	Υ 2. 2. 0	60.56. c	Σ 22.39.30	0.0612	Dec. 8.00. 6	9.22.30	Direct.
1682	Υ 21.16.30	17.56. 0	Σ 2.52.45	9.765877	Sept. 4.07.39	108.33.45	Retrog.
1683	Π 23.23. c	33.11. 0	Π 25.29.30	9.748343	Jul. 3. 2.50	87.53.30	Retrog.
1684	Σ 28.15. c	55.48.40	Π 28.52. 0	9.982339	Mai 29.10.16	29.23.00	Direct.
1686	Σ 20.24.10	21.21.40	Π 17.00.30	9.511883	Sept. 6.14.33	86.25.50	Direct.

This Table needs little Explication, since 'tis plain enough from the Titles, what the Numbers mean. Only it may be observ'd, that the *Perihelium* Distances, are estimated in such parts, as the Middle Distance of the Earth from the Sun, contains 100000.

*A General Table for Calculating the
Motions of Comets in a Parabolical
Orbit.*

Mea. mor.	Ang. a peribelio.	Logar. pro dist. à Sole.	Mea. mor.	Ang. a peribelio.	Logar. pro dist. à Sole.
0	gr. ' "		0	gr. ' "	
1	1.31.40	0.000077	31	42.55.06	0.062400
2	3. 3.15	0.000309	32	44. 3.20	0.065838
3	4.34.43	0.000694	33	45.10.29	0.069319
4	6. 6. 0	0.001231	34	46.16.35	0.072839
5	7.37. 1	0.001921	35	47.21.36	0.076396
6	9. 7.43	0.002759	36	48.25.33	0.079984
7	10.38. 2	0.003745	37	49.28.27	0.083600
8	12. 7.54	0.004876	38	50.30.19	0.087244
9	13.37.17	0.006151	39	51.31. 8	0.090910
10	15. 6. 7	0.007564	40	52.30.56	0.094596
11	16.34.20	0.009115	41	53.29.44	0.098300
12	18. 1.54	0.010798	42	54.27.32	0.102019
13	19.28.47	0.012609	43	55.24.21	0.105752
14	20.54.54	0.014550	44	56.20.12	0.109490
15	22.20.14	0.016607	45	57.15. 6	0.113240
16	23.44.44	0.018783	46	58. 9. 3	0.116995
17	25. 8.22	0.021072	47	59. 2. 4	0.120756
18	26.31. 8	0.023470	48	59.54.11	0.124518
19	27.52.55	0.025969	49	60.45.25	0.128278
20	29.13.47	0.028570	50	61.35.45	0.132035
21	30.33.40	0.031263	51	62.25.14	0.135792
22	31.52.32	0.034045	52	63.13.51	0.139544
23	33.10.23	0.036916	53	64. 1.40	0.143291
24	34.27.12	0.039864	54	64.48.38	0.147019
25	35.42.59	0.042892	55	65.34.50	0.150762
26	36.57.41	0.045989	56	66.20.13	0.154482
27	38.11.20	0.049154	57	67.04.50	0.158192
28	39.23.54	0.052382	58	67.48.42	0.161890
29	40.35.23	0.055668	59	68.31.50	0.165578
30	41.45.47	0.059009	60	69.14.16	0.169254

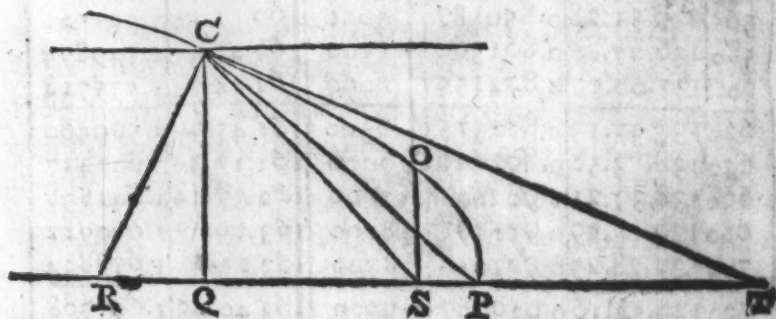
Med. mot.	Angul. à peribelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. à peribelio.	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
61	69.55.58	0.172914	91	86.20.34	0.274176
62	70.36.56	0.176557	92	86.46.20	0.277239
63	71.17.16	0.180188	93	87.11.43	0.280284
64	71.56.56	0.183803	94	87.36.45	0.283306
65	72.35.57	0.187404	95	88.01.27	0.286308
66	73.14.15	0.190978	96	88.25.49	0.289293
67	73.51.59	0.194540	97	88.49.48	0.292252
68	74.29. 6	0.198085	98	89.13.32	0.295201
69	75.05.38	0.201614	99	89.36.54	0.298122
70	75.41.35	0.205122	100	90.00.00	0.301030
71	76.16.56	0.208612	102	90.45.14	0.306782
72	76.51.43	0.212080	104	91.29.18	0.312469
73	77.25.57	0.215529	106	92.12.14	0.318060
74	77.59.41	0.218963	108	92.54. 4	0.323587
75	78.32.54	0.222378	110	93.34.52	0.329042
76	79. 5.35	0.225769	112	94.14.40	0.334424
77	79.37.45	0.229142	114	94.53.30	0.339736
78	80. 9.23	0.232488	116	95.31.22	0.344979
79	80.40.34	0.235809	118	96. 8.22	0.350153
80	81.11.16	0.239127	120	96.44.30	0.355262
81	81.41.31	0.242416	122	97.19.48	0.360306
82	82.11.19	0.245684	124	97.54.17	0.365284
83	82.40.40	0.248933	126	98.28.00	0.370200
84	83. 9.34	0.252159	128	99.00.57	0.375052
85	83.38. 4	0.255366	130	99.33.11	0.379842
86	84. 6. 8	0.258552	132	100. 4.43	0.384576
87	84.33.49	0.261720	134	100.35.45	0.389252
88	85. 1. 5	0.264865	136	101. 5.48	0.393868
89	85.27.58	0.267989	138	101.35.22	0.398428
90	85.54.27	0.271092	140	102. 4.19	0.402920

Med. mot.	Ang. à perihelio.	Logar. pro. dist. à Sole.	Med. mot.	Ang. à perihelio	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
142	102.32.41	0.407380	204	113.37.25	0.523406
144	103.00.31	0.411784	208	114. 9.52	0.529705
146	103.27.47	0.416132	212	114.41.23	0.535886
148	103.54.31	0.420430	216	115.12.02	0.541958
150	104.20.43	0.424676	220	115.41.51	0.547922
152	104.46.22	0.428866	224	116.10.52	0.553782
154	105.11.33	0.433012	228	116.39. 7	0.559538
156	105.36.16	0.437110	232	117. 6.38	0.565199
158	106.00.32	0.441164	236	117.33.27	0.570762
160	106.24.23	0.445178	240	117.59.35	0.576233
162	106.47.47	0.449144	244	118.25. 5	0.581616
164	107.10.44	0.453060	248	118.49.57	0.586912
166	107.33.17	0.456936	252	119.14.14	0.592122
168	107.55.27	0.460772	256	119.37.56	0.597252
170	108.17.14	0.464208	260	120. 1. 6	0.602301
172	108.38.37	0.468318	264	120.23.44	0.607274
174	108.59.39	0.472030	268	120.45.52	0.612174
176	109.20.20	0.475705	272	121. 7.30	0.616998
178	109.40.40	0.479340	276	121.28.39	0.621750
180	110.00.40	0.482937	280	121.49.22	0.626438
182	110.20.20	0.486498	284	122. 9.38	0.631056
184	110.39.41	0.490022	288	122.29.28	0.635608
186	110.58.44	0.493512	292	122.48.54	0.640098
188	111.17.28	0.496965	296	123. 7.57	0.644525
190	111.35.55	0.500384	300	123.26.36	0.648893
192	111.54.05	0.503769	310	124.11.40	0.659559
194	112.11.58	0.507121	320	124.54.36	0.669880
196	112.29.34	0.510441	330	125.35.34	0.679876
198	112.46.55	0.513729	340	126.14.44	0.689568
200	113. 4.00	0.516984	350	126.52.12	0.698970

Med. mot.	Ang. a perihelio.	Logar. pro dist. à Sole.	Med. mot.	Ang. a perihelio.	Logar. pro dist. à Sole.
o	gr. ' "		o	gr. ' "	
360	127.28. 6	0.708104	820	141.49.24	0.970836
370	128. 2.33	0.716976	840	142.10.00	0.978397
380	128.35.38	0.725606	860	142.29.56	0.985771
390	129. 7.27	0.734006	880	142.49.10	0.992970
400	129.38. 4	0.742186	900	143. 7.48	0.100000
410	130. 7.34	0.750160	920	143.25.51	1.006871
420	130.36. 2	0.757930	940	143.43.21	1.013586
430	131. 3.30	0.765516	960	144.00.18	1.020155
440	131.30. 2	0.772918	980	144.16.46	1.026583
450	131.55.41	0.780148	1000	144.32.46	1.032876
460	132.20.30	0.787216	1500	149.26. 8	1.158188
470	132.44.32	0.794122	2000	152.26.15	1.246058
480	133. 7.50	0.800882	2500	154.32.20	1.313703
490	133.30.25	0.807494	3000	156. 7.27	1.368678
500	133.52.20	0.813969	3500	157.22.49	1.414974
520	134.34.18	0.826522	4000	158.14.36	1.454950
540	135.14. 0	0.838600	4500	159.16.36	1.490125
560	135.51.28	0.850187	5000	160. 1.12	1.521521
580	136.27. 6	0.861369	5500	160.40. 5	1.549874
600	137.00.57	0.872155	6000	161.14.24	1.575718
620	137.33.13	0.882575	6500	161.45.00	1.599460
640	138. 3.58	0.892649	7000	162.12.34	1.621417
660	138.33.21	0.902401	7500	162.37.34	1.641838
680	139. 1.29	0.911866	8000	163.00.23	1.660922
700	139.28.25	0.921012	8500	163.21.20	1.678834
720	139.54.16	0.929907	9000	163.40.42	1.695708
740	140.19. 5	0.938549	9500	163.58.38	1.711662
760	140.42.56	0.946951	10000	164.15.20	1.726784
780	141.05.55	0.955124	50000	170.52. 0	2.197960
800	141.28. 3	0.963082	100000	172.45.44	2.399655

*The Construction and Use of the
general Table.*

As the Planets move in *Elliptick* Orbs, so do the Comets in *Parabolick* ones, having the Sun in their common *Focus*, and describe equal *Area's* in equal *Times*. But now because all *Parabola's* are *similar* to one another, therefore if any determinate Part of the *Area* of a given *Parabola*, be divided into any Number of Parts at Liberty, there will be a *like* Division made in all *Parabola's*, under the same Angles, and the Distances will be proportional: And consequently this one Table of ours will serve for all Comets. Now, the Manner of the Calculation of this Table is thus: In the *Fig.*



Let S be the *Sun*, POC the Orbit of a Comet, P the *Perihelion*, O the Place where the Comet is 90 gr. distant from the Sun, C any other Place. Draw the Right Lines CP, CS, and make ST, SR, equal to CS; and then having drawn the Right Lines CR, CT, (whereof the one is a Tangent, and the other a Perpendicular to the Curve) let fall CQ perpendicular to the *Axis* PSR.

Now,

Now, any *Area*, as COPS, being given, 'tis requir'd to find the Angle CSP, and the Distance CS. From the Nature of the *Parabola* RQ is ever $= \frac{1}{2}$ the Parameter of the *Axis*, and consequently if the Parameter be put $= 2$, then RQ $= 1$. Let CQ $= z$; then PQ shall $= \frac{1}{2} z z$, and the Parabolick Segment COP $= \frac{1}{12} z z z$. But the Triangle CSP will $= \frac{1}{4} z$, and so the Mixtilineal *Area* COPS $= \frac{1}{12} z^3 - \frac{1}{4} z = a$, whence $z^3 + 3z = 12a$. Wherefore resolving this Cubical Equation, z or the Ordinate CQ will be known. Now, let the *Area* OPS be propos'd to be divided into 100 Parts; this *Area* is $\frac{1}{12}$ of the Square of the Parameter, and consequently $12a$ is $=$ that Square $= 4$. If therefore the Roots of these Equations $z^3 + 3z = 0, 04 : 0, 08 : 0, 12 : 0, 16$, &c. be successively extracted, there will be obtain'd so many z or Ordinates CQ respectively, and the *Area* SOP will be divided into 100 Parts. And in like manner is the *Calculus* to be continued beyond the Place O. Now the Root of this Equation (since RQ is $= 1$) is the Tabular Tangent of the Angle CRQ, or $\frac{1}{2}$ the Angle CSP, and so the Angle CSP is given. And RC, the Secant of the same Angle CRQ, is a mean Proportional between RQ or Unity, and RT, which is the Double of SC, as is plain from the *Conicks*. But if SP be put $= 1$, and so the *Latus Rectum* $= 4$ (as in our Table) then RT will be the Distance sought, viz. the Double of SC in the former *Parabola*. After this manner therefore, I compos'd the foregoing Table, which serves to represent the Motions of all Comets: For hitherto there has been none observ'd, but comes within the Laws of the *Parabola*.

It

It remains now, that we give the Rules for the Calculation, and shew the Way of determining the Place of a Comet seen, by these Numbers. *The Velocity of a Comet moving in a Parabola, is every where to the Velocity of a Planet describing a Circle about the Sun, at the same Distance from the Sun, as $\sqrt{2}$ to 1. as appears from Cor. 7. Prop. 16. Lib. 1. of the Princip. Phil. Nat. Math.* If therefore a Comet in its *Perihelium* were suppos'd to be as far distant from the Sun as the Earth is, then the *Diurnal Area* which the Comet wou'd describe, wou'd be to the *Diurnal Area* of the Earth, as $\sqrt{2}$ to 1. And consequently, the Time of the Annual Revolution, is to the Time in which such a Comet wou'd describe a Quadrant of its Orbit from the *Perihelium*, as 3.14159, &c. (that is the *Area* of the Circle) to $\sqrt{9}$. Therefore the Comet wou'd describe that Quadrant in 109 Days, 14 Hours, 46 Minutes; and so that *Parabolick Area* (Analogous to the *Area POS*) being divided into 100 Parts, to each Day there wou'd be allotted 0.912280. of those Parts; the Log. of which, viz. 9.960128, is to be kept for continual Use. But then the Times in which a Comet, at a greater or less Distance, wou'd describe similar Quadrants, are as the Times of the Revolutions in Circles, that is, in the *Sesquiplicate Ratio* of the Distances: And so the *Diurnal Area's*, estimated in *Centesimal Parts* of the Quadrant (which Parts we put for Measures of the mean Motion, like Degrees) are in each, in the *Subsesquialtera* Proportion of the Distance from the Sun in the *Perihelion*.

These

These necessary Things premis'd, let it be propos'd to compute the *apparent Place* of any one of the mention'd Comets, for any *Given Time*. Therefore,

1. Let the *Sun's Place* be had, and the *Log.* of its *Distance* from the *Earth*.

2. Let the *Difference* between the *Time* of the *Perihelion*, and the *Time* given, be gotten, in *Days* and *Decimal Parts* of *Days*. To the *Log.* of this *Number*, let there be added the constant *Log.* 9.960128, and the *Complement Arithmetical* of the $\frac{2}{3}$ of the *Log.* of the *Distance* in the *Perihelium* from the *Sun*: The *Sum* will be the *Log.* of the *Mean Motion*, to be sought in the first *Column* of the *General Table*.

3. With the *Mean Motion* let there be taken the correspondent *Angle* from the *Perihelium*, in the *Table*, and the *Log.* for the *Distance* from the *Sun*: Then in *Comets* that are *Direct*, add, and in *Retrograde* ones subtract; if the *Time* be after the *Perihelium*, the *Angle* thus found, to or from the *Place* of the *Perihelion*; or in *Direct* *Comets*, subtract; and in *Retrograde* ones, add; if the *Time* be before the *Perihelion*, the foresaid *Angle* to or from the *Place* of the *Perihelion*; and so we shall have the *Place* of the *Comet* in its *Orbit*. And to the *Log.* found for the *Distance*, let there be added the *Log.* of the *Distance* in the *Perihelion*, and the *Sum* will be the *Log.* of the true *Distance* of the *Comet* from the *Sun*.

4. The *Place* of the *Node*, together with the *Place* of the *Comet* in its *Orbit*, being given, let the *Distance* of the *Comet* from the *Node* be found; then, the *Inclination* of the *Plane* being given, there will be given also (from the common *Rules* of *Trigonometry*) the *Comet's Place* reduced to the *Ecliptick*, the *Inclination* or *Heliocentrick Latitude*, and the *Log.* of the *curtate Distance*.

5. From

5. From these Things given (by the very same Rules that we find the Planets Places, from the Sun's Place and Distance given) we may obtain the Apparent or Geocentrick Place of the Comet, together with the Apparent Latitude. And this it may be worth while to illustrate by an Example or two.

EXAMPLE I.

Let it be requir'd to find the Place of the Comet of the Year 166⁵, March 1^d, 7^h, 00', P. M. London. That is. 96^d, 19^h, 8', after the Perihelion, which happen'd Novemb. 24^o, 11^h, 52'.

Log. Dist. Perihel.	0. 011044
Log. Sesquialt.	0. 016566
Comp. Arith.	9 983434
	9. 960128
Log. Temp.	1. 985862
Log. Med. Mot.	1. 929424
Medius Motus	85.001
Perihel. Ω	10. 41. 25
Ang. Corresp.	83. 38. 05—
Comet. in Orb. $\propto$	17. 3. 20
Ascend. Nod. Π	21. 14. 00
Com. à Nodo	34. 10. 40
Red. ad Eclip.	32 19. 05
Com. Helioc. $\propto$	18. 54. 55
Incl. Bor.	11. 46. 50
Log. pro dist.	0. 255369
Log. Perihel.	0. 011044
Co-fin. Incl.	9 990754
Log. dist. Curt.	0. 257167
Log. dist. $\odot$	9. 997918
	21. 44. 45
Com. Visus γ	29. 18. 30
Lat. Visa	8. 36. 15

EXAM.

EXAMPLE II.

Let it be requir'd to find the Place of the Comet of the Year 1683, July 23^o, 13^h, 35', P.M. London: Or, 13^h, 40' *Equat. Time.* That is, 21^d, 10^h, 50' after the Perihelion.

Log. dist. Perihel.	9. 748343
Log. Sefquialt.	9. 622514
Comp. Arith.	0. 377486
	9. 960128
Log. Temp.	1. 310723
Log. Med. Mot.	1. 648337
Medius Motus	44. 498
Perihel. II	25. 29. 30
Ang. Corresp.	56. 47. 20
Comet. in Orb. γ	28. 42. 10
Nod. Descend. $\propto$	23. 23. 00
Com. à Nodo	35. 19. 10
Red. ad Eclip.	4. 48. 30
Com. Helioc. $\propto$	28. 11. 30
Incl. Bor.	35. 2. 00
Log. pro dist.	0. 111336
Log. Perihel.	9. 748343
Co-fin. Incl.	9. 913187
Log. dist Curt.	9. 772866
Log. dist. $\odot$.	0 006104
$\odot$ Locus Ω	10. 41. 25
Com. Visus $\odot$	5. 11. 50
Lat. Bor.	28. 52. 00

At the Instant of Time specified in the first Example, 'twas observ'd (at *London*) that the Comet applied to the Second Star of *Aries*; so that it was found to be 9' more Northerly,
C
and

and 3' to the East, according to Mr. *Hook's* Observation. But at that of the Second Example, I my self (near *London*, with the same Instruments whereby I formerly observ'd the Southern Constellations) found the Place of the Comet to be $5^{\circ}, 11'$, and $28^{\circ}, 52'$ North Latitude, which agreed exactly with the Observation made at *Greenwich* almost the very same Moment.

As for the Comet of the Year 1680, which came almost to the very *Sun* it self (being in its *Perihelion*, not above $\frac{1}{3}$ of the *Semi-Diameter* of the *Sun* distant from the Surface of it) since the *Latus Rectum* is so very small, could hardly be contained within the Limits of the General Table, because of the excessive Velocity of the *Mean Motion*. Therefore in this Comet, the best Way is (after the *Mean Motion* is found) to get from thence (by the Help of the foregoing Equation $z^3 + 3z = \frac{4}{100}$ of the *Mean Motion*) the Tangent of Half the Angle from the *Perihelion*, together with the Log. for the Distance from the *Sun*. Which Things being given, we are to proceed by the same Rules, as in the rest.

After this Manner therefore, the Astronomical Reader may examine these Numbers, which I have calculated, with all imaginable Care, from the Observations I have met with. And I have not thought fit to make them publick before they have been duly examin'd, and made as accurate as 'twas possible, by the Study of many Years. I have publish'd this Specimen of Cometical Astronomy, as a *Prodromus* of a designed future Work, lest, happening
to

to die, these Papers might be lost, which every Man is not capable to retrieve, by reason of the great Difficulty of the Calculation. Now, it may not be amiss to put the Reader in mind, That our Five first Comets, (the Third and Fourth observ'd by *Peter Apian*, the Fifth by *Paulus Fabricius*) as also the Tenth seen by *Mästlin*, if I mistake not, in the Year 1596. are not so certain as the rest; for the Observations were made neither with fit Instruments, nor due Care, and upon that Account are disagreeing with themselves, and can by no means be reconcil'd with a regular Computation. The Comet which appear'd in the Year 1684. was only taken Notice of by *Blanchinus*, who observed at *Rome*: And the last, which appear'd in the Year 1698. was seen only by those at *Paris*, who determin'd its Course in a very uncommon Way. This Comet was very obscure; and, altho' it mov'd swift, and came near enough our Earth; yet we, who are wont to be curious enough in these Matters, saw nothing of it. For want of Observations I have left out of the foregoing Catalogue, those Two remarkable Comets which have appear'd in this our Age, one in *November*, in the Year 1689. the other in *February* in the Year 1702. For they directing their Course towards the Southern Parts of the World, and being scarce conspicuous here in *Europe*, met with no Observers capable of the Business. But, if any one shall bring from *India*, or the Southern Parts, an accurate Series of requisite Observations, I will willingly fall to work again, and undergo the Fatigue of representing their Orbits in Numbers, as I have done the rest.

By comparing together the Accounts of the Motions of these Comets, 'tis apparent, their Orbits are dispos'd in no manner of Order; nor can they, as the Planets are, be comprehended within a *Zodiack*, but move indifferently every Way, as well Retrograde as Direct; from whence it is clear, they are not carry'd about or mov'd in *Vortices*. Moreover, the Distances in their *Perihelium's* are sometimes greater, sometimes less; which makes me suspect, there may be a far greater Number of them, which moving in Regions more remote from the Sun, become very obscure; and wanting Tails, pass by us unseen:

Hitherto I have consider'd the Orbits of Comets as exactly *Parabolick*; upon which Supposition it wou'd follow, that Comets being impell'd towards the Sun by a Centripetal Force, descend as from Spaces infinitely distant, and by their Falls acquire such a Velocity, as that they may again run off into the remotest Parts of the Universe, moving upwards with such a perpetual Tendency, as never to return again to the Sun. But since they appear frequently enough, and since none of them can be found to move with an *Hyperbolick* Motion, or a Motion swifter than what the a Comet might acquire by its Gravity to the Sun, 'tis highly probable they rather move in very *Excentrick* Orbits, and make their Returns after long Periods of Time: For so their Number will be determinate, and, perhaps, not so very great. Besides, the Space between the Sun and the fix'd Stars is so immense, that there is Room enough for a Comet to revolve, tho' the Period of its Revolution be vastly long.

Now,

Now, the *Latus Rectum* of an *Ellipsis*, is to the *Latus Rectum* of a *Parabola*, which has the same Distance in its *Perihelium*; as the Distance in the *Aphelium* in the *Ellipsis*, is to the whole *Axis* of the *Ellipsis*. And the Velocities are in a Subduplicate *Ratio* of the same: Wherefore in very Excentrick Orbits this *Ratio* comes very near to a *Ratio* of Equality; and the very small Difference which happens on Account of the greater Velocity in the *Parabola*, is easily compensated in determining the Situation of the Orbit. The principal Use therefore of this Table of the Elements of their Motions, and that which induced me to construct it, is, That whenever a new Comet shall appear, we may be able to know, by comparing together the Elements, whether it be any of those which has appear'd before, and consequently to determine its Period, and the *Axis* of its Orbit, and to foretell its Return. And, indeed, there are many Things which make me believe that the Comet which *Apian* observ'd in the Year 1531. was the same with that which *Kepler* and *Longomontanus* took Notice of and describ'd in the Year 1607. and which I my self have seen return, and observ'd in the Year 1682. All the Elements agree, and nothing seems to contradict this my Opinion, besides the Inequality of the Periodick Revolutions: Which Inequality is not so great neither, as that it may not be owing to Physical Causes. For the Motion of *Saturn* is so disturbed by the rest of the Planets, especially *Jupiter*, that the Periodick Time of that Planet is uncertain for some whole Days together. How much more therefore will a Comet be subject to such like Errors, which rises al-

almost Four times higher than *Saturn*, and whose Velocity, tho' encreased but a very little, would be sufficient to change its Orbit, from an Elliptical to a Parabolical one. This, moreover, confirms me in my Opinion of its being the same; that in the Year 1456. in the Summer time, a Comet was seen passing Retrograde between the Earth and the Sun, much after the same Manner: Which, tho' no Body made Observations upon it, yet from its Period, and the Manner of its Transit, I cannot think different from those I have just now mention'd. Hence I dare venture to foretell, That it will return again in the Year 1758. And, if it should then return, we shall have no Reason to doubt but the rest must return too: Therefore Astronomers have a large Field to exercise themselves in for many Ages, before they will be able to know the Number of these many and great Bodies revolving about the common Center of the Sun; and reduce their Motions to certain Rules. I thought, indeed, that the Comet which appear'd in the Year 1532. might be the same with that observ'd by *Hevelius* in the Year 1661. But *Apian's* Observations, which are the only ones we have concerning the first of these Comets, are too rude and unskilful, for any thing of Certainty to be drawn from them, in so nice a Matter. I design to treat of all these Things in a larger Volume, and contribute my utmost for the Promotion of this Part of Astronomy, if it shall please God to continue my Life and Health.

In the mean time, those that desire to know how to construct Geometrically the Orb of a Comet, by Three accurate Observations given,
may

may find it at the End of the Third Book of Sir *Isaac Newton's* Principles of Natural Philosophy, entituled *De Systemate Mundi*, in the Words of its renowned Inventor. Which have since been more fully explained by my very worthy Collegue *Dr. Gregory*, in his Learned Work of *Astronomia Physica & Geometrica*.

One Thing more perhaps it may not be improper or unpleasant to advertise the Astronomical Reader; That some of these Comets have their Nodes so very near the Annual Orb of the Earth, that if it shall so happen, that the Earth be found in the Parts of her Orb next the Node of such a Comet, whilst the Comet passes by; as the apparent Motion of the Comet will be incredibly swift, so its *Parallax* will become very sensible; and the Proportion thereof to that of the Sun will be given. Wherefore such Transits of Comets do afford us the very best Means, though they seldom happen, to determine the Distance of the Sun and Earth: Which hitherto has only been attempted by *Mars* in his Opposition to the Sun; or else *Venus* in *Perigæo*; whose *Parallaxes* though triple to that of the Sun, are scarce any ways to be perceived by our Instruments; whence we are still in great Uncertainty in that Affair. This use of Comets was the ingenious Thought of that excellent Geometrician *Mr. Nicolas Facio*. Now the Comet of 1472, had a *Parallax* above Twenty times greater than the Sun's. And if the Comet of 1618, had come down, about the Middle of *March*, to his descending Node: Or if that of 1684, had arrived a little sooner at its ascending Node, they would have been yet much nearer the
Earth,

Earth, and consequently have had more notable *Parallaxes*. But hitherto none has threaten'd the Earth with a nearer Appulse, than that of 1680. For by Calculation I find, that Novemb. 11^o, 1^h, 6ⁱ, P. M. that Comet was not above the Semi-diameter of ~~the~~ the Sun to the Northwards of the Way of the Earth. At which Time, had the Earth been there, the Comet would have had a *Parallax* equal to that of the Moon, as I take it. This is spoken to Astronomers: But what might be the Consequences of so near an Appulse; or of a Contact; or, lastly, of a Shock of the Cœlestial Bodies, (which is by no means impossible to come to pass) I leave to be discuss'd by the Studious of Physical Matters.

F I N I S.

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